

Patent
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REMARKS

Claims 27-44 are pending in the application. Claim 38 has been amended to correct dependency. Claims 27 and 30 are the only independent claims under consideration.

Paragraph 2 – Status Request

Paragraph 2 of the Action requests a status update of co-pending application. Parent application 10/103,674, filed March 21, 2002, has issued as US Patent 6,686,244. The specification has been amended to update this status information.

Paragraph 3 – New Title

Paragraph 3 of the Action suggests a new title. The title kindly suggested by the Examiner had been incorporated herewith.

Paragraph 4 – Section 112, second paragraph

Claim 38 was rejected under 35 USC 112, second paragraph, as indefinite. Claim 38 has been amended to correctly depend from Claim 36 rather than Claim 37.

Paragraphs 5-7 – 102(c) and 103(a) rejections

Claims 27-35 and 39-43 were rejected under 35 USC 102(e) as being anticipated by US Patent 6,649,459 (Deboy et al.), Claims 36 and 37 were rejected under 35 USC 103(a) as being unpatentable over Deboy in view of US Patent 6,376,878 (Kocon), and Claim 44 was rejected as being unpatentable over Deboy in view of US Patent 5,216,275 (Chen).

Each of the rejections is respectfully traversed and reconsideration is requested.

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Independent Claim 27 is directed to a power semiconductor device made in accordance with the steps of providing a substrate of a first conductivity type; forming a voltage sustaining region on said substrate by: (1) depositing an epitaxial layer on the substrate, the epitaxial layer having a first or a second conductivity type, (2) forming at least one terraced trench in the epitaxial layer, the terraced trench having a trench bottom and a plurality of portions that differ in width to define at least one annular ledge therebetween, (3) depositing a barrier material along the walls and bottom of the trench, (4) implanting a dopant of a conductivity type opposite to the conductivity type of the epitaxial layer through the barrier material lining at the at least one annular ledge and at the trench bottom and into adjacent portions of the epitaxial layer to respectively form at least one annular doped region and another doped region, (5) diffusing the dopant in the at least one annular doped region and the another doped region to cause the at least one annular doped region and the another doped region to overlap one another, whereby a continuous doped column is formed in the epitaxial layer, and (6) depositing a filler material in the terraced trench to substantially fill the terraced trench; and, finally, forming over the voltage sustaining region at least one region of conductivity type opposite to the conductivity type of the epitaxial layer to define a junction therebetween.

The Office Action discusses "product by process limitations" on page 4 (and again on pages 6 and 8), noting that a "product by process claim directed to the product per se, no matter how actually made". Applicants of course agree that it is the "patentability of the final structure of the product 'gleaned' from the process steps, which must be determined in a 'product by process' claim, and not the patentability of the process" (MPEP 2113). However, to the extent that the process limitations distinguish the product over the prior art, they must be given the same consideration and weight in assessing the differences between the claimed subject matter and the prior art (Graham v. John Deere Co., 383 US 1, 148 USPQ 523 (1973)).

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Applicant further appreciates that the burden is on the Applicant to present evidence from which the examiner could reasonably conclude that the claimed product is patentably distinct from the product of the prior art, and in this case, Applicant submits that the prior art (and Deboy in particular) does not necessarily or inherently possess the characteristics of the claimed product as defined by each of independent Claims 27 and 30.

Applicant respectfully submits that a key to the fabrication of the device made in accordance with the limitations recited in each of independent Claims 27 and 30 is depositing a uniform layer of material after the terraced trench has been cleared of any non-silicon layers. This uniform layer prevents implanted ions from reaching the silicon in the trench sidewall regions perpendicular to the wafer surface while allowing the ions to penetrate through to the substrate on the horizontal surface (see attached Figure "A" for illustration). After the implant is performed, a subsequent diffusion step redistributes the dopant atoms that reached the silicon to the final profile. The resulting dopant atoms form a deeper junction perpendicular to the wafer substrate (see attached Figure "B" for illustration).

In this regard, independent Claim 27 recites, in part, "(3) depositing a barrier material along the walls and bottom of the trench, (4) implanting a dopant of a conductivity type opposite to the conductivity type of the epitaxial layer *through the barrier material lining at the at least one annular ledge and at the trench bottom and into adjacent portions of the epitaxial layer to respectively form at least one annular doped region and another doped region, (5) diffusing the dopant in the at least one annular doped region and the another doped region to cause the at least one annular doped region and the another doped region to overlap one another, whereby a continuous doped column is formed in the epitaxial layer,*" and, independent Claim 30 recites, in part, "at least one doped column having a dopant of a conductivity type opposite to the conductivity type of the epitaxial layer, said doped column *being formed from at least one annular doped region and another doped region diffused into one another*, said at least one annular region and said another doped region being located in said epitaxial layer adjacent to and below said at least one annular ledge and said trench bottom, respectively".

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These product-by-process limitations, in combination with each of the additional recited elements, result in a product that is patentably distinguishable over the cited art, and over Deboy in particular, and Applicant therefore respectfully requests reconsideration of the outstanding rejections.

For at least the foregoing reasons, each of independent Claims 27 and 30 is believed to be clearly patentable over Deboy. In addition, dependent Claims 28-29 and 31-44 are believed patentable as depending from a patentable independent Claim 27 or 30, and for reciting further distinguishing limitations thereover.

Since the Applicant has fully responded to each rejection set out in the Office Action, it is respectfully submitted that in regard to the above amendment and remarks that the pending application is patentable over the art of record and prompt review and issuance is accordingly requested. Should the Examiner be of the view that an interview would expedite consideration of this Amendment or of the application at large, request is made that the Examiner telephone the Applicant's undersigned attorney at (908) 518-7700 in order that any outstanding issues be resolved.

Respectfully submitted,


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